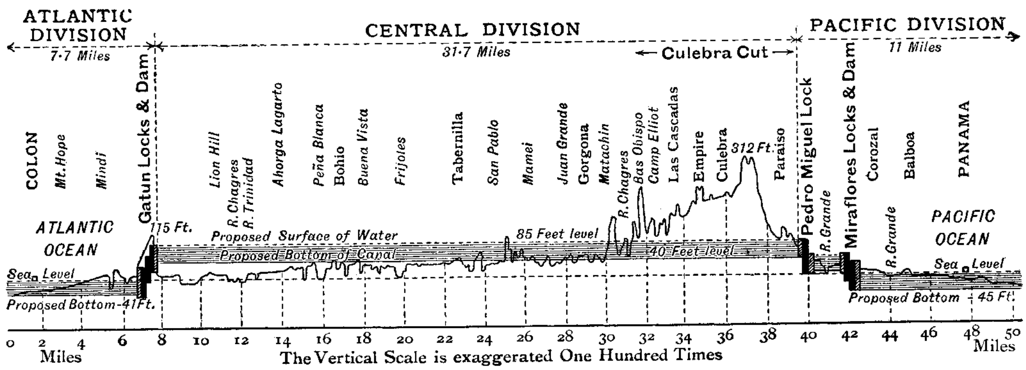
be rejected, and would have cost more than the total outlay on the Department."

In response to the strong recommendations of the Royal Commission, the Imperial Government has recently agreed in principle to the continued maintenance of the central office of the department for a further period of ten years from April 1. This will enable the department under Dr. Watts (the present Commissioner) to continue to coordinate the work of scientific agriculture in the West Indies, to carry on research, and afford still further assistance in developing the resources of the colonies.

THE PANAMA CANAL IN 1910.[1]

THE canal now being constructed by the American Government in continuation of the work commenced by de Lesseps is 50½ miles long from deep water in the Caribbean to deep water in the Pacific. Of this distance 34 miles is high-level with 8 miles sea-level at each end, as shown on the accompanying profile. The water for lockage is supplied by blocking the lower valley of the Chagres River at Gatun with an earthen dam 7000 feet long, 115 feet high, and about 2000 feet broad. This consists of two heaps of broken rock enclosing the hydraulic fill, *i.e.* silt pumped in wet and allowed to drain. This packs tightly under the pressure of the atmosphere, and secures the impermeability of the dam. The heavy rock fills secure its stability against the lateral pressure of the 85 feet of water which will be behind the dam. The height now attained by the dam is 70 feet. The underlying ground is somewhat soft, but it has not been squeezed up owing to the way the load has been spread. The sides of the dam, in fact, hold down the ground so that the weight of the central portion cannot squeeze it up.



Profile of Panama Canal.

The elaborate investigations of the engineers on the spot have shown that the foundations are impervious, the earlier official reports to the contrary having been based upon a misinterpretation of the borings. The area of the lake which will be maintained between this dam and that at Pedro Miguel will be 164 square miles, or twice the size of the Lago Maggiore.

The dimensions of the locks are: length, 1000 feet; breadth, 110 feet. The minimum depths in canal and locks will be 41 feet. The minimum bottom width in the 8 miles of the Culebra cut, 300 feet. The rest of the canal will have a bottom width of from 500 to 1000 feet. The profile shows the greatest original elevation of the ground to be 312 feet, but this is on the central line. On the eastern side at the same place the escarpment began at 534 feet. The bottom will be at 40 feet above mean sea-level, so that the cutting here will be nearly 500 feet deep. The depth of water in this portion of the canal will be 45 feet, the surface being therefore 85 feet above mean sea-level.

The principal difficulty in construction is caused by landslides, brought about by the action of rain, of which 90 inches falls in the year at Culebra. The basalt rock is overlaid with disintegrated rock and with clay to an average thickness of 15 to 20 feet, and the rock itself in places has open joints or seams, either vertical or sloping towards the cut. Frequently the first sign of a landslide is the bulging up or humping of the basalt rock at the bottom of the cut, which sometimes rises 20 feet. Simultaneously a crack appears on the soil above, which is followed by foundering of the soil and clay, and very often of the rock. Obviously, so long as humping of the bottom occurs, it would be futile to let in water, as the canal might be at any moment so reduced in depth as to be unnavigable. It is proposed to deal with the difficulty by flattening the slopes until gravitational equilibrium is achieved, on the principle already referred to in the case of the Gatun dam.

The author points out the existence of a gravitative wave in landslides, and recommends the application of the principles and terminology of surface waves to their study.

In spite of the difficulty of the landslides, the opening of the canal may be expected on the promised date, viz. January 1, 1915.

[1] Abstract of a paper read before the Royal Society of Arts on December 9 by Dr. Vaughan Cornish.

APPLIED GEOLOGY IN THE UNITED STATES.[1]

THE eight bulletins referred to below cover a wide range of applied geology, and contain many valuable additions to academic geology. Thus the memoir by Messrs. Hillebrand and Schaller is a most important contribution to knowledge of the minerals containing mercury. It gives the result of a thorough research on kleinite, montroydite, terlinguaite, and eglestonite. The two last are proved to be oxychlorides, and montroydite to be an oxide of mercury, confirming the conclusions of Prof. Moses, the founder of these species. Kleinite was named in 1905 by Prof. Sachs, who described it as an oxychloride of mercury, but the day after his paper was

[1] F. C. Schrader: Mineral Deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Arizona. U.S. Geol. Survey, Bull. 397. Pp. 226+xvi plates+37 figs. (Washington, 1909.)
E. F. Burchard and C. Butts: Iron Ores, Fuels, and Fluxes of the Birmingham District, Alabama, with chapters on the Origin of the Ores, by Edwin C. Eckel. U.S. Geol. Survey, Bull. 400. Pp. 204+xvii plates, +19 figs. (Washington, 1910.)
W. F. Hillebrand and W. T. Schaller: The Mercury Minerals from Terlingua, Texas. U.S. Geol. Survey, Bull. 405. Pp. 174+vi plates+44 figs. (Washington, 1909.)
W. H. Emmons: A Reconnaissance of some Mining Camps in Elko, Lander, and Eureka Counties, Nevada. U.S. Geol. Survey, Bull. 408. Pp. 130+v plates+22 figs. (Washington, 1910.)
A. G. Maddren: The Innoko Gold-Placer District, Alaska, with Accounts of the Central Kuskokwim Valley and the Ruby Creek and Gold Hill Placers. U.S. Geol. Survey, Bull. 410. Pp. 87+v plates. (Washington, 1910.)
F. L. Hess: A Reconnaissance of the Gypsum Deposits of California, with a Note on Errors in the Chemical Analysis of Gypsum, by George Steiger. U.S. Geol. Survey, Bull. 413. Pp. 37+iv plates+2 figs. (Washington, 1910.)
F. L. Ransome: Notes on some Mining Districts in Humboldt County, Nevada. U.S. Geol. Survey, Bull. 414. Pp. 75+i plate+7 figs. (Washington, 1909.)
The Valuation of Public Coal Lands. G. H. Ashley: The Value of Coal Land. C. A. Fisher: Depth and Minimum Thickness of Beds as Limiting Factors in Valuation. U.S. Geol. Survey, Bull. 424. Pp. 75. (Washington, 1910.)

read, in Berlin Hillebrand announced that the mineral is a mercury-ammonium compound; it is a mixture of mercury ammonium chloride with some sulphate or oxysulphate. Some interesting photographs illustrate the optical heterogeneity of the mineral. Kleinite is hexagonal in symmetry, but basal sections are only singly refracting when heated above 130°; after cooling very slowly, in process of years, again become biaxial.

Three of these bulletins (Nos. 397, 408, and 414) state the results of inspections of western mineral fields where mining was once more active than it is now. Mr. F. C. Schrader describes the ore deposits of Mohave County, in north-western Arizona. The country consists of a plateau of pre-Cambrian gneisses covered in places by Cainozoic volcanic rocks, and flanked by Palæozoic sediments in the valley of the Colorado River. The climate is warm, and with a 5-inch rainfall and high evaporation there is little surface water, and the rocks are oxidised to the depth of usually from 200 to 600 feet. The mines are numerous, but they are all hampered by the difficulties of access and high costs, and so none have been worked very deeply. The outcrops were removed thirty years ago. The mines belong to two main types, one represented in the Cerbat Range, occurring in the pre-Cambrian rocks, and the other, as in the Black Mountain, found in the Cainozoic volcanic formation. The ores in the latter are found only in association with chloritic andesites. The field shows many points of interest, and the results will be watched with interest as the mines go deeper. The plans suggest that some of the ore shoots have been formed from ascending solutions. The evidence available is insufficient to throw much light on general problems, but Mr. Schrader's report will be indispensable in the future development of the field.

Mr. W. H. Emmons's reconnaissance on some mining camps in Nevada also deals with small scattered mines of which most of the direct evidence has been lost. Some of them were worked fifty years ago, and mining was most active during the silver boom of the 'eighties. The mines, unlike those in Mohave County, yield a large variety of minerals. The area consists of Palæozoic sediments, ranging from the Cambrian to the Carboniferous, which have been invaded by Cretaceous granodiorites, and covered in places by Miocene rhyolites, andesites, and basalts. One series of mines consists of replacements in what the author calls the "marbleised limestone" around the Cretaceous granodiorites, and a second series occurs with the Cainozoic eruptives, but only in association with the andesites; the basalts are always barren, and the rhyolites are only productive when near andesite. The chief metals in both series of mines are gold and silver. The gold is relatively more abundant in the older lodes, where it is associated with copper and lead. The mines only occur where the rocks have been leached by hot water, and thus prospectors recognise promising positions by the colour of the weathered rocks.

Mr. F. L. Ransome has examined Humboldt County, Nevada, of which the map prepared by the historic Survey of the Fortieth Parallel is still the best. Mining began in the district about 1860 on ores of antimonial silver with stibnite and cinnabar. In Copperwood Canyon small veins of nickel and cobalt ores occur in an altered andesite beside a diorite, probably of Cretaceous age. Mr. Ransome shows his characteristic insight in the classification of the ore bodies and in such illuminating diagrammatic sections as that of the Sheba mine (p. 42).

The gypsum deposits of California are described in a short memoir by Mr. F. L. Hess. The gypsum is mined for use as plaster and a fertiliser. Some of it occurs in "gypsite," a material containing grains of gypsum too small to be readily discernible to the eye. It is there an efflorescent product, due to the evaporation of water, which has percolated through underlying gypsiferous beds. Some massive deposits formed by the evaporation of shallow lakes and by precipitation in shallow sea water are also of local commercial value. The veins of gypsum, including both selenite and satinspar, have no intrinsic value, but are worked as the cheapest method of holding mineral leases on land which may yield oil. Sufficient work is done on the gypsum to maintain the lease without the expense of boring for oil, and thus dodging the law by using one mineral to maintain an unfair claim to another.

The valuation of coal lands is a problem which has long taxed the ingenuity of experts on mining law. In Bulletin 424 Mr. Fisher contributes to the discussion a summary of the depth and minimum thickness of coal seams worked in various countries. The deepest coal mining recorded is from 3937 feet, in Belgium; the deepest in Britain is at 3483 feet, in Rams Mine, Pendelton; and depths of more than 3000 feet have been reached in France and Germany. Forty years ago a British Coal Commission recognised that mining would reach a depth of 4000 feet, but such is the wealth in fuel of the United States that coal below 3000 feet is still disregarded in valuation. The United States, moreover, has not yet been driven to work such thin coals as are wrought in England and Belgium. The thinnest English seams worked at present independently are a cannel coal of 8 inches and ordinary coal 10 inches thick. Seams 12 inches thick are worked in Belgium and Scotland, where beds of less than 2 feet thick are worked extensively.

The red iron ores in the Silurian rocks of Alabama, described in Bulletin 400, are second in importance in the United States only to those of the Lake Superior district. They are low-grade ores, but being near fluxes and fuel are cheaply worked. The Clinton ores have generally been regarded as a residual deposit due to concentration of iron oxide by solution of a ferruginous limestone. This view has been based upon the belief, due to Porter and I. C. Russell, that the ironstones pass below into normal limestone. This view has been accepted by many later economic geologists, but is rejected by Eckel, as the ore is already being mined far from the outcrop, and has been found in New York in bores ten to fifteen miles from the outcrop, and nearly 1000 feet below the surface. The ore is often oolitic and contains many marine fossils which have been altered into iron oxide, but that this change happened during the deposition of the rock is indicated by several facts. Thus many of the oolitic grains contain a nucleus of quartz grains surrounded by concentric layers of iron ore, which is covered by carbonate of lime. A fuller account and figures of the microscopic structure of the ores would have been useful. As the oolitic grains have been cemented by iron oxide, some replacement appears to have taken place after the formation of the bed. Mr. Eckel, however, produces weighty evidence in support of his view that the ore is mainly of contemporary origin, though recent work shows that other American geologists reject this explanation, and regard the estimates based on it as exaggerated.

The brown ores of Alabama are admitted by Mr. Eckel to be epigenetic; they are interbedded with Cambro-Ordovician, Cretaceous, and Cainozoic rocks, but are all of Cainozoic formation.

Mr. Maddren's report on some Yukon placer deposits shows that the gold has been derived from lodes formed by the intrusions of acid rocks in Mesozoic or Lower Cainozoic times. The gold is usually coarse, but its concentration has been slow, because the cold acts as a cementing agent, and the erosion of the frozen ground is very slow. The report gives some interesting information as to the relative extent of Glacial and post-Glacial denudation in some Alaskan valleys.

J. W. G.

ON THE SENSIBILITY OF THE EYE TO VARIATIONS OF WAVE-LENGTH IN THE YELLOW REGION OF THE SPECTRUM.[1]

DR. EDRIDGE-GREEN[2] has introduced a method of classifying colour-vision by determining the number of separate parts or divisions in the spectrum within each of which the observer can perceive no colour difference. Movable screens are provided in the focal plane of the spectroscopic telescope, by which the part admitted to the eye is limited and the limits measured in terms of wave-length. Beginning at the extreme visible red, more and more of the spectrum is admitted until a change of colour (not merely of brightness) is just perceptible. This gives the first division. The second division starts from the place just determined, and is limited in the direction of

[1] Abstract of a paper read before the Royal Society on December 8, 1910, by Lord Rayleigh, O.M., F.R.S.

[2] Roy. Soc. Proc., B, 1910, vol. lxxxii., p. 458, and earlier writings.